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THE VIRGINIA JOURNAL OF SCIENCE

A JOURNAL ISSUED QUARTERLY BY THE
VIRGINIA ACADEMY OF SCIENCE

Vol. 11, New Series | January, 1960 | No. 1

VOL. 11, NEW SERIES No. 1

JANUARY, 1960

THE VIRGINIA JOURNAL OF SCIENCE

PUBLISHED FOUR TIMES A YEAR IN JANUARY, APRIL, JULY, AND SEPTEMBER, BY THE VIRGINIA ACADEMY OF SCIENCE

Printed by *The Bassett Printing Corporation*, Bassett, Virginia

CONTENTS

Pages

A Note on the Oxygen and Temperature Tolerances of the Triclads *Phagocata gracilis* (Haldeman) and *Dugesia tigrina* (Girard). Betty J. Abbott 1

Ground Vegetation Patterns of the Spruce-Fir Area of the Great Smoky Mountains National Park. Dorothy L. Crandall 9

A Study of Some Soil-Inhabiting Phycomycetes from Haiti. William W. Scott 19

Experimental Infections of Chick Embryos with *Tetrahymena pyriformis*. Jesse C. Thompson, Lynne Santy and Valer Clark 25

A Study of the Chlorophyta of the James River Basin, Virginia. II Ecology. B. R. Woodson 27

News and Notes 37

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Entered as second-class matter, at the post office at Bassett, Virginia, and Blacksburg, Virginia, under the Act of March 3, 1897. Subscription $3.00 per volume. Published four times a year: in January, April, July, and September, by the Virginia Academy of Science at Farmville, Va.

Mailed March 21, 1960

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THE VIRGINIA
JOURNAL OF SCIENCE

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A NOTE ON THE OXYGEN AND TEMPERATURE TOLERANCES OF THE TRICLADS PHAGOCATA GRACILIS (HALDEMAN) AND DUGESIA TIGRINA (GIRARD)

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Studies of the relationship between physiological variation in animals, such as the work by Prosser (1955), have shown the importance of such variation in the problems of adaptation and distribution. It has been the purpose of this investigation to attempt to determine the oxygen and temperature tolorances of populations of two species of the triclad family Planariidae, *Phagocata gracilis* (Haldeman) and *Dugesia tigrina* (Girard). A treatment of the broader aspects of their ecology and evolution has not been attempted here. However, it is hoped that the results of this study will be of interest to the students of adaptation in this group.

Respiration in the triclads is undoubtedly of the ordinary aerobic type (Hyman, 1951b). According to Lund (1921) and Hyman (1929, 1951b) the rate of oxygen consumption of the *Dugesia* species is constant at different oxygen concentrations in the water until the concentration falls below about one-third saturation. Hyman (1929) reported that several species of planaria can live in oxygen concentrations as low as 0.4cc/liter and concludes that planaria are more or less independent of oxygen concentration.

In any attempt to determine the toleration of planaria to low levels of oxygen concentrations, consideration must be given to the effect of carbon dioxide. According to Anderson (1927), the accumulation of carbon dioxide does not effect the results of oxygen tolerance tests. Hyman (1925) stated that both low oxygen and carbon dioxide concentrations are of importance in affecting the rate of respiration, but that neither are controlling factors.

Perhaps the classic example of acclimation among planaria is seen in the stenothermous European forms *Dugesia gonocephala*, *Polycelis felina*,

and *Crenobia alpina* which occur along streams with increasing altitude and decreasing temperature in the order named (Hyman, 1951b). However, according to Hyman (1951b), most fresh water forms are eurythermous, that is, they are indifferent to a relatively wide change of temperature.

Most of the publications dealing with temperature studies are concerned with temperature as it affects oxygen consumption. Behre (1918), in studies of acclimation of planaria to rise in temperature, concluded that acclimation consists of changes which manifest themselves physiologically as a gradual decrease in the rate of metabolism or oxidation which enables them to be highly adapted to temperature acclimation. According to Hyman (1951b), planarians react to a temperature change of 20° to 30°C from that at which they have been living and Mast (1903) has shown that, when placed in a temperature gradient, *Dugesia dorotocephala* which had been living at a temperature of 22°C aggregated in a zone ranging from 17° to 26°C. Eddy and Gleim (1932) found that *Phagocata gracilis* aggregated at 0° to 10°C regardless of whether they were taken from their natural habitat at 9.5°C or kept for a month in the laboratory at 20° to 22° C. The thermal death point of *Phagocata gracilis* was found by these authors to be 30°C.

In view of the evidence presented in work previously done, which is related to temperature and oxygen tolerances, further study seems indicated that might show more clearly comparisons and differences between planaria found in widely different habitats. It was with this in mind that the present study was undertaken.

METHODS

Specimens of *Phagocata gracilis* used in this study were taken from the Heath Spring in Radford, Virginia, a location from which Kenk (1935) collected specimens of the same species. The spring has a sandy bottom, contains considerable *Spirogyra* sp., and periodic temperature checks made for the past year (1958) indicated that the temperature varied from 9° to 11°C. The pH of the water averaged 5.77, as determined by three tests made at different times. Oxygen content in three tests was 4.7 ppm, 4.4 ppm and 4.1 ppm, averaging 4.4 ppm. *Dugesia tigrina* specimens were taken from Stroubles Creek draining the "Duckpond" located on the V.P.I. campus in Blacksburg, Virginia. The stream bed here is rocky, with some clay and sand. It shows some evidence of pollution. The average pH was found to be 8.25, and the dissolved oxygen content of the water in three tests was 11.5 ppm, 11.9 ppm, and 11.1 ppm, showing an average oxygen content of 11.5 ppm. Stream temperatures were found to vary from 8° to 24°C during the year.

Identification of species used was made by the author and was based

upon serial sections as well as external characteristics. The specimens were compared with descriptions offered by Kenk (1935) and Hyman (1937, 1951a).

In determining tolerances to low oxygen concentrations, specimens were placed in 125 ml of water (taken from the stream in which the animals were collected and de-oxygenated by bubbling nitrogen through it) which was introduced into a mason jar of one pint capacity under a heavy layer of mineral oil. After introducing the water and the specimens, the jar was completely filled with mineral oil to prevent the entrance of oxygen, sealed, and returned to constant temperature storage in the laboratory. Oxygen concentrations present in all tests were determined by the Winkler method. Tolerance to increased temperature was determined by placing the specimens individually in 3 ml tubes which in turn were placed in a rheostat controlled water bath. The temperature was increased at the rate of 0.2°C every five minutes from 20°C (which was the temperature at which both species were kept for approximately 24 hours before the temperature and oxygen tests – this is in accord with the work of Eddy and Gleim, 1932, in their temperature toleration experiments and with the work of Hyman, 1925, in her oxygen consumption tests) until all specimens showed no response to stimuli and were therefore assumed to be dead. Specimens were "double checked" as to whether or not they were dead by returning them to laboratory storage for twenty-four hours to see if any revived. None did. Four tests were run for each species, with thirty specimens tested each time. All specimens were checked every five minutes, and the dead were recorded and removed from the water bath. Constant temperature tolerances were determined by placing the planaria in 400 ml beakers containing 300 ml of water. In both types of temperature tolerance tests the specimens were placed in water from their original habitat which was aerated just before using to prevent oxygen deficiency. These beakers were placed in the water bath and constant temperature maintained. Constant temperature tests for each species were begun at the "LD-50" level or mean lethal temperature of each species as determined by their tolerance to slowly increased temperature. Specimens were checked hourly until all were dead, or inactive for twenty-four hours.

RESULTS

There appears to be a marked difference in the oxygen requirements of *Dugesia tigrina* and *Phagocata gracilis*. In three tests involving 120 specimens of *Phagocata gracilis*, the amount of dissolved oxygen remaining in the water after the specimens were dead was 0.23 ppm, 0.52 ppm, and 0.39 ppm, which averaged 0.38 ppm. Three experiments with the same number of *Dugesia tigrina* disclosed rather high amounts of dissolved oxygen remaining in the water, 1.21 ppm, 1.37 ppm, 1.13 ppm for an average

of 1.23 ppm. In view of other work which has been done (Hyman, etc., previously cited) this seemed rather high and replicates were made of these experiments. Here the amount of dissolved oxygen remaining in the water was 1.34 ppm, 1.67 ppm, and 1.18 ppm, for an average of 1.24 ppm (Table 1).

A significant difference exists between the temperature tolerances of *Dugesia tigrina* and *Phagocata gracilis* as revealed by the experiments in which the temperature was raised slowly. With *Dugesia tigrina* the temperature range in °C was from 35.5 to 39.4, the mean was 37.7°, standard deviation 0.79, and the standard error of the mean 0.07. In the case of *Phagocata gracilis*, the temperature range in °C was from 30.5 to 34.9, the mean was 33.3, standard deviation 0.68, and standard error of the mean 0.06. Applying the "T" test, the difference is significant beyond the 0.01 level (Table 2).

Exposure to constant temperatures indicate that the highest temperature possible for survival of *Dugesia tigrina* lies below 34.7°C and is apparently around 33.7°C. The survival temperature for *Phagocata gracilis* is between 30.3°C and 29.3°C (Table 3.).

TABLE 1

Dissolved oxygen present in water after death of planaria

(40 planaria used for each test)

	Heath Spring (*Phagocata gracilis*)	Duckpond (*Dugesia tigrina*)	Duckpond Replicates
Test No. 1	0.23 ppm	1.21 ppm	1.34 ppm
Test No. 2	0.52 ppm	1.37 ppm	1.67 ppm
Test No. 3	0.39 ppm	1.13 ppm	1.18 ppm
Average	0.38 ppm	1.23 ppm	1.24 ppm

67 453 A A 30

TABLE 2

Mortality of *Dugesia tigrina* and *Phagocata gacilis* when the temperature was raised at the rate of 0.2°C every five minutes.

Dugesia tigrina		*Phagocata gracilis*	
°C	Number Dead	°C	Number Dead
39.0 - 39.4	1	34.5 - 34.9	2
38.5 - 38.9	22	34.0 - 34.4	29
38.0 - 38.4	34	33.5 - 33.9	34
37.5 - 37.9	25	33.0 - 33.4	28
37.0 - 37.4	18	32.5 - 32.9	14
36.5 - 36.9	9	32.0 - 32.4	5
36.0 - 36.4	8	31.5 - 31.9	3
35.5 - 35.9	3	31.0 - 31.4	3
		30.5 - 30.9	2
Total	120	Total	120
Mean (M)	37.70	Mean (M)	33.30
Standard Deviation	0.79	Standard Deviation	0.68
Standard Error of M	0.07	Standard Error of M	0.06

TABLE 3

Results of constant temperature tests showing the mortality of *Dugesia tigrina* and *Phagocata gracilis* according to hourly checks.

Temp. °C.	Hours 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15-24	Total Dead	Alive
																Dugesia tigrina	
37.7	41	60	29													120	0
36.7	2	41	58	19												120	0
35.7	0	3	54	25	4	2	1									120	0
34.7	0	0	0	0	0	0	0	1	3	7	31	44	20	14		120	0
33.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120
																Phagocata gracilis	
33.3	21	41	27	20	11											120	0
32.3	1	23	56	44	10	6										120	0
31.3	0	0	0	0	1	1	11	34	41	23	7					120	0
30.3	0	0	0	0	0	3	9	17	24	35	15	0	0	0	0	103	17
29.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120

DISCUSSION

There is an apparent species difference in the oxygen requirements of the two species studied. However, in view of the fact that the high oxygen concentration in the water (ave. 11.5 ppm) was so near the saturation point, it is believed that the oxygen requirements of *Dugesia tigrina* (ave. 1.23 ppm remaining at death) may result in part from acclimation to high amounts of dissolved oxygen in the water. It is noted that in the case of *Phagocata gracilis*, where the average oxygen content of the water was 4.4 ppm, only an average of 0.36 ppm of oxygen remained in the water after oxygen toleration tests. It is not felt that the pH of the water was a factor in influencing oxygen requirements since the work of Hyman (1925) and Anderson (1927) indicated that a pH between 5.0 and 9.5 does not

affect the rate of oxygen consumption. This point might be worthy of further study.

Both species were collected at a time when the water in their respective habitats was at a temperature of 10°C. Eddy and Gleim (1932) have shown that laboratory storage at 20° does not affect lethal temperature and it is felt that this is borne out by this study. The difference in the lethal temperature of *Phagocata gracilis* as reported by Eddy and Gleim (1932) and that found in this study is due to intraspecific variation. However, other factors such as differences in method, temperatures tested, or length of the experiment may be partially responsible for the difference noted. Morphological variations in this species were remarked upon by Hyman (1937) after comparing Kenk's (1935) description of animals from Heath's Spring with specimens from other localities. Further morphological study is indicated which should include more comprehensive information regarding the Heath Spring specimens of *Phagocata gracilis*.

ACKNOWLEDGEMENTS

The writer is grateful to Dr. Perry C. Holt of the Department of Biology at the Virginia Polytechnic Institute for help in planning the investigation reported here and in the preparation of the manuscript. Also the author wishes to thank Dr. F. S. Orcutt, V.P.I., for the use of laboratory facilities under his direction, and Prof. Betty V. Conner, V.P.I., Lt. James W. Berry, U.S.A., and Miss Carolyn S. Obenshain, M.C.V. for their assistance at various times during the study in collecting specimens.

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GROUND VEGETATION PATTERNS OF THE SPRUCE-FIR AREA OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK[1]

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Although the spruce-fir area of the Southern Appalachians has interested several investigators, there have been few studies of the herbaceous plants in relation to the canopy and none with this relationship as the primary objective. Because the forest-site concept has never been specifically applied to the Southern Appalachian coniferous forests, an intensive study of the spruce-fir areas in the Great Smoky Mountains National Park was made with particular emphasis on the herbaceous and shrubby plant cover.

The Committee on Forest Terminology of the Society of American Foresters (1944) defines site as "An area considered as to its capacity to produce forests or other vegetation, the combination of biotic, climatic and soil conditions." This corresponds to the term habitat as used by many ecologists. In characterizing and classifying forest sites different investigators have used either characteristics of the forest stand itself or environmental factors. Many of these attempts have used a single factor such as moisture, land form or chemical soil analysis, but no single criterion can in itself adequately describe a site since the site type depends upon the interaction of all the edaphic, climatic and biotic factors.

Since a plant responds to the conditions about it, it is in a sense, a measure of its environment. Thus the plants of any given community reflect the interaction of the many environmental factors and these individual plants or plant communities have been used as indicators of habitat or site. Because of the greater number of species involved and because of the more rapid response to changes in their surroundings, herbaceous plants have been more frequently used than woody shrubs and trees as indicators of site. Individual plant species have been valuable in the West, but in general a plant community or group of plants will provide a more complete and satisfactory basis for an estimate of the environment.

One of the first to develop a system of forest site types based upon ground cover vegetation was the Finnish forester, A. K. Cajander (1926,

[1]This paper is a portion of an article published in Ecological Monographs, 28:337-360, October, 1958.

1949). The use of ground vegetation in distinguishing forest site types in North America has been attempted by several investigators. These studies have included various coniferous forests in Western United States and Canada. Possible site types for the Southern Appalachians are included in R. H. Whittaker's 1956 report on *Vegetation of the Great Smoky Mountains* in which he lists 5 subtypes for spruce forests and 4 subtypes for fir forests. Using site counts and general estimation of coverage, Whittaker correlates site types with a series of topographic subtypes.

The specific areas selected for this study have been within accessible regions of the spruce-fir area in the Great Smoky Mountains National Park. These include samples from Mt. Le Conte, Mt. Sterling, Spruce Mountain and within an area extending from 10 miles northeast of Newfound Gap to the southernmost limit of spruce and fir in the Park, about 5 miles west of Clingmans Dome.

During the summers of 1951, 1953, 1955, and 1956, field data were collected in the following manner. A 50-meter rope marked off in 5-meter intervals was laid out twice in a "T" pattern, with one line across the slope and the other at right angles to the first. Herbaceous species were recorded for each 5-meter interval of a strip 1-meter wide and for each one meter section of the first 5-meters of the first strip. Coverage for herbaceous plants, including mosses, was recorded as percentage of line covered, using decimeter units following the sampling method employed in the Holly Shelter Wildlife Management Area by Wells (1946). For shrubs, numbers and heights were tabulated for each 5-meter interval of the meter wide strip giving a total area of 100 square meters. In this strip, seedlings and small trees were simply recorded as present if less than 6 inches high, and those at least 6 inches high up to 1 inch d.b.h. were tallied by numbers and heights.

Canopy and understory trees 1 inch d.b.h. and over were recorded by species and measured diameters. In 50 of the samples a strip 10-meters wide along the two 50-meter lines was employed while in 20 of the samples the strip was 5-meters wide. In 9 samples only one strip 50-meters long by 10-meters wide was used because of difficulty of terrain or in some cases because the particular spruce-fir community was not extensive enough to include a second sample at right angles to the first.

Notes on slope, exposure, elevation and general description were recorded for each sample. A few heights were recorded by means of the Abney level, but because of the density of the canopy and irregularities of the terrain this was exceedingly difficult. Estimates of heights were employed in the latter cases.

Although the number of tree species involved in the southern boreal forest is low and the canopy layer is floristically simple, much greater

variation is found in the lower strata and these differences in undergrowth patterns are the basis for the site types that have been designated. In many instances the boundary line between two adjacent site types is sharp but in others there is a recognizable ecotonal or transitional area between the two.

Most of these coniferous forests in the Smokies are mixtures of fir and spruce, but with increase in altitude there is a corresponding increase in fir and nearly pure fir forests occur at elevations above 6400 feet. The fir in the Park is Fraser fir, *Abies fraseri*, and the spruce is red spruce, *Picea rubens*. Fraser fir is endemic to the Southern Appalachians while the red spruce has a much wider range occurring as far north as Maine and Nova Scotia. Oosting and Billings (1951), in comparing the northern and southern spruce-fir forests of the Appalachians, concluded that these two forests are part of the boreal forest formation but with two distinct phases, the red spruce–Fraser fir and the red spruce-balsam fir.

At the higher altitudes the most frequent deciduous tree in the coniferous forests is the mountain ash, *Pyrus americana*, while abundant yellow birch *Betula alleghaniensis*, is found at the middle and lower elevations. Occasional beech, *Fagus grandifolia*, hemlock, *Tsuga canadensis*, yellow buckeye, *Aesculus octandra*, and sugar maple, *Acer saccharum* may be encountered at the lower spruce-fir elevations.

Eight site types and one subtype based upon differences in the undergrowth patterns have been designated for these forests. The occurrence of these site types under the various forest types are summarized in Table 1.

The Oxalis-Hylocomium site type, characterized by high coverage of feather mosses, occurs on steep northerly slopes at very high elevations or on somewhat more moderate slopes or nearly level areas at mid-elevations. Above 6000 feet the dominant tree is Fraser fir while at moderate altitudes red spruce becomes the codominant canopy tree. On both these fir and spruce-fir sites there are many stems, generally of small diameters, rather straight and tall with a considerable number of standing dead stems, especially fir in the 1-4 inch diameter classes. Mountain ash is an occasional canopy tree on the fir sites and yellow birch is more frequently encountered on the spruce-fir sites. Considerable fir reproduction may occur on the more level area in the lower altitude mixed forest. Similar species of herbaceous plants are found on the two sites, chiefly *Aster acuminatus*, *Clintonia borealis* and the two ferns *Dryopteris spinulosa v. americana* and *Athyrium filix-femina*. The forest floor is wet with seeping water or mountain springs and the substratum is rocky, typically of loose slabs of slate which are covered with luxuriant mosses and give a hummocky appearance to the lower strata. These mosses, which are designated

feather mosses in this paper, may consist of nearly 100 per cent *Hylocomium splendens, Hypnum crista-castrensis* and *Hylocomium umbratum*. Much of the debris from fallen trees is wet, rotten and covered with filmy mosses and liverworts. Windthrow may be particularly disastrous in the fir stands at the higher elevations resulting in extensive even-aged stands. These are probably the stands described by Cain in 1931 as stagnant pole stands, since there may be many stems rather closely spaced and frequently many of these in the same diameter class.

The Oxalis-Dryopteris fir site type may be observed in the very high elevation forests on Mt. Le Conte and Clingmans Dome. The slopes are usually slight or moderate and exposure may be in any direction. The moss layer ranges from low in coverage to very high on the more moist sites where the fern coverage is less. The latter type may approach the Oxalis-Hylocomium type just described. In those instances where the fern coverage is nearly 100 per cent, the moss and Oxalis layers are considerably reduced. The most common herbaceous plants occuring with the ferns are *Aster acuminatus, Solidago glomerata, Clintonia borealis, Stachys clingmanii* and *Chelone lyoni. Trillium erectum, Angelica triquinata, Streptopus roseus, Impatiens pallida* and patches of *Houstonia serpyllifolia* may be found. Shrubs few in number, may include *Vaccinium erythrocarpum, Menziesia pilosa, Sambucus pubens* and occasionally *Virburnum alnifolium. Abies fraseri* frequently attains 95 per cent or more of the basal area. The firs are branchy, much moss covered, and frequently dripping with moisture from the enveloping clouds. The trees appear stunted, measuring from 35-50 feet in height and are somewhat distantly spaced giving a parklike or open woods appearance to these forests. *Pyrus americana* and *Picea rubens* are occasionally present.

The Hylocomium-Vaccinium site type occurs in both the spruce-fir and the spruce forests on steep or precipitous slopes. Feather mosses form a treacherous mat over the underlying rocks and fallen timber rotten and moist may be criss-crossed over these rocks and this too is overlain with a deep moss layer. The characteristic herbs in the fir forest include *Aster acuminatus, Clintonia borealis, Solidago glomerata* and *Senecio rugelia*. Frequently fir reproduction is high, solid patches of one to two-foot seedlings occurring in openings created by the death or fall of canopy trees. The total coverage of herbs exclusive of *Oxalis montana* and ferns is usually under 15 per cent and there may be a continuous low shrub stratum of *Vaccinium erythrocarpum*. Canopy trees are not large in diameter and in the understory there are many stems both living and dead in the small diameter classes.

The Virburnum-Vaccinium-Dryopteris site type occurs in fir, spruce-fir and spruce forests. These forests show a characteristic five-storied development in the undergrowth layers, moss-Oxalis-fern-Vaccinium-Virbur-

num. The fir sites generally have a higher coverage of moss and Oxalis compared to those of lower altitudes in the spruce-fir and spruce forests. Much of the moss in the fir site type is *Hylcomium splendens*, while this species may be absent on the spruce site. This site type supports the best developed stands of the mixed spruce-fir forest type.

Excellent examples of the Senecio site type may be observed in the vicinity of Clingmans Dome on steep slopes, generally of southwest or northwest exposure. *Oxalis montana* and ferns are low in coverage, but *Senecio rugelia* may cover nearly 100 per cent of the ground. The bryophytic layer is sparse and mosses and liverworts are of several species with little *Hylocomium splendens* in the mixture. Frequently as the surface becomes more level, especially near the top of the ridges, there may be a perceptible increase in coverage of fern and *Solidago glomerata*. The canopy trees are chiefly *Abies fraseri* of relatively small diameter.

The Viburnum-Vaccinium-Senecio site type occurs on steeper and drier sites than the Viburnum-Vaccinium-Dryoteris site type. Exposures are generally west, northwest or southwest. Moss, Oxalis and fern coverages are low in this site type and *Senecio rugelia* may be of moderately high coverage with usually some ground covered only by needles and dry litter. Spruce trees of very large diameters are encountered on this and the following type.

The Viburnum-Vaccinium-Lycopodium site type is the most prevalent site type in the spruce forests of the Great Smoky Mountains National Park. Much of the ground is bare of plants and covered with needles and fallen debris, the latter only partially encrusted with thin filmy mosses and liverworts. The high percentage of needle cover distinguishes this site type from the slightly more moist Viburnum-Vaccinium-Senecio type under spruce-fir. *Lycopodium lucidulum* and *Medeola virginiana* are frequently conspicuous and are good indicators of this type. *Senecio rugelia*, ferns and mosses may be present in the pockets and depressions but total coverage of ground plants is lowest of any site type. Shrubs are frequently only scattered. The spruce trees are of relatively large diameter and the total basal area may be high.

The Rhododendron site type extends throughout the southern boreal forest. At high elevations under a canopy of fir the most important shrubs are *Rhododendron carolinianum* and *R. catawbiense* with *Menziesia pilosa* and *Diervilla sessilifolia* in the more open area. The ground cover varies from nearly zero on the more exposed ridges and crags to nearly 100 percent *Hylocomium splendens*, *Sphagnum* sp. and other mosses on the steep wet north slopes. At lower elevations spruce becomes the dominant canopy tree and *Rhododendron maximum* and *Kalmia latifolia* with perhaps *Leucothoe editorum* and *Smilax rotundifolium*, become increas-

ingly important. Adjacent to the dry heath balds the ground cover consists of only an extremely low coverage of lichens and mosses with an occasional specimen of *Trillium undulatum*, *Galax aphylla*, *Lycopodium clavatum* or *L. obscurum*. Here the spruce and fir trees are taller and of larger diameter. With increasing amounts of *Viburnum* in the tall shrub layer, yellow birch becomes a more important tree and the fern and herb coverages are greater. Where there is a mixture of *R. maximum*, *R. catawbiense* and *Viburnum alnifolium* in the tall shrub layer this type may approach the Viburnum-Vaccinium-Dryopteris site type. It is this type that has been designated as the Rhododendron (Viburnum) subtype. The spruce trees on this type are frequently of large diameters and more than 100 feet in height. In addition to spruce, yellow birch is usually an important canopy tree.

TABLE I

OUTLINE OF SITE TYPES OF THE SPRUCE-FIR AREA OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK

Fir Forests (6200-6600 Feet)	Spruce-Fir Forests (5500-6400 Feet)	Spruce Forests (5100-6000 Feet)
Oxalis-Hylocomium	Oxalis-Hylocomium	
Oxalis-Dryopteris		
	Hylocomium-Vaccinium	Hylocomium-Vaccinium
Viburnum-Vaccinium-Dryopteris	Viburnum-Vaccinium-Dryopteris	Viburnum-Vaccinium-Dryopteris
Senecio		
	Viburnum-Vaccinium-Senecio	
		Viburnum-Vaccinium-Lycopodium
Rhododendron	Rhododendron	Rhododendron
	Rhododendron (Viburnum)	Rhododendron (Viburnum)

SUMMARY

Forest-site types and various interrelationships of the upper and lower strata of the spruce-fir forests of the Great Smoky Mountains National Park are discussed. Based upon frequency and coverage of species of shrubs and herbaceous plants, the eight site types proposed for the southern boreal forest are as follows:

1. Oxalis-Hylocomium
2. Oxalis-Dryopteris
3. Hylocomium-Vaccinium
4. Viburnum-Vaccinium-Dryopteris
5. Senecio
6. Viburnum-Vaccinium-Senecio
7. Viburnum-Vaccinium-Lycopodium
8. Rhododendron

ACKNOWLEDGEMENTS

The author acknowledges her appreciation to Dr. Royal E. Shanks, Department of Botany, The University of Tennessee, for his guidance during the course of the study. Arthur Stupka, Park Naturalist of the Great Smoky Mountains National Park and Dr. Maxwell E. Springer, Associate Agronomist, Agricultural Experiment Station, The University of Tennessee were also of assistance.

APPENDIX

SPECIES CHARACTERISTIC OF SPRUCE-FIR FORESTS

Canopy Trees

Abies fraseri (Pursh) Poir.
Amelanchier laevis Weig.
Betula alleghaniensis Britton
Fagus grandifolia Ehrh.
Picea rubens Sarg.
Prunus pensylvanica L.
Pyrus americana (Marsh.) DC.

Understory Trees

Acer pensylvanicum L.
Acer spicatum Lam.
Cornus alternifolia L.
Ilex montana T. and G.

Shrubs

Diervilla sessilifolia Buckl.
Hydrangea arborescens L.
Kalmia latifolia L.
Lonicera canadensis Bartr.
Menziesia pilosa (Michx.) Juss.
Pieris floribunda (Pursh) B. and H.
Pyrus melanocarpa (Michx.) Willd.
Rhododendron carolinianum Rehder
Rhododendron catawbiense Michx.
Rhododendron maximum L.
Ribes rotundifolium Michx.
Rubus canadensis L.
Sambucus pubens Michx.
Smilax rotundifolia L.
Vaccinium simulatum Small
Vaccinium erythrocarpum Michx.
Viburnum alnifolium Marsh.
Viburnum cassinoides L.

Herbaceous Flowering Plants

Agrostis alba L.
Angelica triquinata Michx.
Arisaema atrorubens (Ait.) Blume
Aster acuminatus Michx.
Aster divaricatus L.
Cardamine clematitis Shuttlw.
Carex brunnescens (Pers.) Poir
Carex debilis var. *rudgei* Bailey
Carex intumescens var. *fernaldii* Bailey
Cheloni lyoni Pursh
Chimaphila maculata (L.) Pursh
Cimicifuga racemosa (L.) Nutt.
Cinna latifolia (Trev.) Griseb.
Circaea alpina L.
Claytonia virginica L.
Clintonia borealis (Ait.) Raf.
Danthonia spicata (L.) Beauv.
Dioscorea villosa L.
Eupatorium rugosum var. *roanense* (Small) Fern.
Galax aphylla L.
Houstonia serpyllifolia Michx.
Impatiens pallida Nutt.

Laportea canadensis (L.) Wedd.
Luzula acuminata Raf.
Luzula bulbosa (Wood) Rydb.
Maianthemum canadense Desf.
Medeola virginiana L.
Mitchella repens L.
Monotropa uniflora L.
Oxalis montana Raf.
Saxifraga micranthidifolia (Haw.) Britt.
Senecio rugelia A. Gray
Smilacina racemosa (L.) Desf.
Smilax herbacea L.
Solidago glomerata Michx.
Stachys clingmanii Small
Strephopus roseus Michx.
Trillium erectum L.
Trillium undulatum Willd.
Viola pallens (Banks) Brainerd
Viola rotundifolia Michx.

Ferns and Club Mosses

Athyrium filix-femina (L.) Roth
Dennstaedtia punctilobula (Michx.) Moore
Dryopteris spinulosa var. *americana* (Fishch.) Fern.
Lycopodium clavatum L.
Lycopodium lucidulum Michx.
Lycopodium obscurum L.
Polypodium virginianum L.

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A STUDY OF SOME SOIL-INHABITING PHYCOMYCETES FROM HAITI

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Although the phanerogamic flora of Haiti is relatively well known, little attention has been devoted to the fungi, particularly to the aquatic and terrestrial phycomycetous taxa. During the summer of 1958, Dr. K. W. King, of the V. P. I. Biology Department, visited this area as a member of a nutritional survey team organized by the Research Corporation and the Institute of Nutrition Sciences, Columbia University. Supported by a research grant from the Virginia Academy of Science, Dr. King collected and returned to this laboratory samples of cultivated field soils and virgin soils from each of the major climatic and geographical areas of Haiti. Collection sites are indicated on the map illustrated in Figure I.

The methods of collection and isolation were essentially those described by Sparrow (1943) and Raper (1937). Pure culture techniques followed closely those described by Johnson (1956). In the following list of fungi identified citations for specific binomials are given, but synonyms are not listed. For synonymous taxa, reference is made to Coker and Matthews (1937), Sparrow (1943), Johnson (1956), and Gilman (1957). All collection sites are shown on the accompanying map (fig. 1).

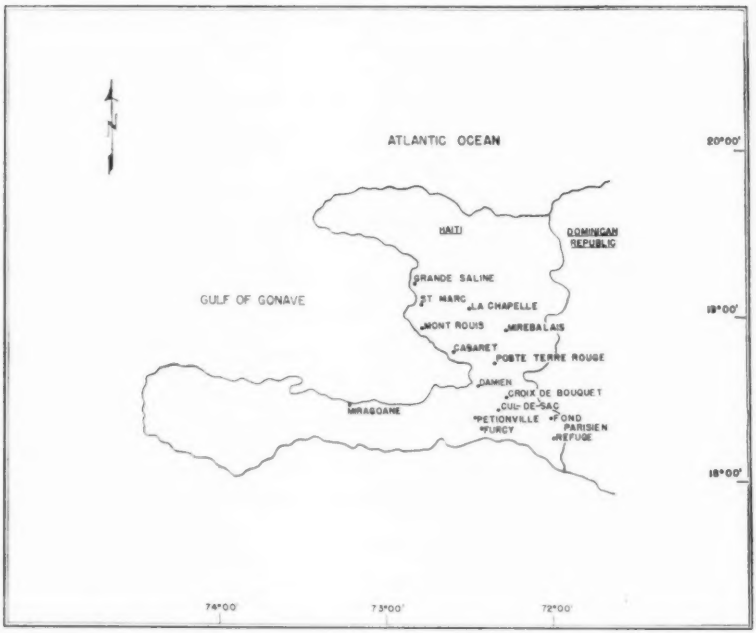
FUNGI COLLECTED

Chytridiales

Rhizophlyctis rosea (deBary and Woronin) Fischer, Rabenhorst Kryptogamen – Fl., *1*: 122. 1892. *R. rosea* was encountered in almost every sample examined. It appeared exclusively on cellophane and grass baits from all sites except 4, 7, 15 and 19. Among the isolates observed, the size and shape of the sporangium, the number of discharge papillae, and the nature of the rhizoidal system varied to a considerable degree. No tendencies toward lobulate sporangia or toward a polycentric type of thallus were noted. The color of the sporangial contents varied from orange to golden brown. The presence of endoopercula was not observed. All isolates as described above may be included in the broad concept of this species. Further study may reveal, however, that the numerous isolates now recognized under the binomial *R. rosea* may represent a complex of several taxa. The designation of such a complex as a single taxonomic entity is arguable.

Rhizophlyctis spp. A number of distinct monocentric chytrids were

Fig. 1. Sketch of the Haitian Republic showing collection sites.



Cabaret	Site 5	Moragoane	Site 19
Cul-de-Sac	Site 1, 6, 10	Mirebalais	Site 21
Croix de Bouquet	Site 3	Mont Rouis	Site 4, 15
Damien	Site 12	Petionville	Site 7
Fond Parisien	Site 17, 22	Poste Terre Rouge	Site 8
Furcy	Site 14, 16, 18	Refuge	Site 9, 20
Grande Saline	Site 13	St. Marc	Site 11
LaChapelle	Site 2		

observed on grass and snake skin baits (sites 1, 2, 3, 11, 14, 16, 18, and 21). Although probably related to *Rhizophlyctis*, positive identification was impossible since the amount of material was limited or, in a number of cases, the forms were incompletely observed.

Cladochytrium replicatum Karling, Amer. Jour. Bot., *18*: 538. 1931. This polycentric chytrid was observed once on grass bait from a soil sample collected near Cabaret (site 5). The Haitian isolate differed in no way from previously described isolates. It is apparently wide spread in its distribution, appearing frequently in soils as a saprophyte on vegetable debris.

Blastocladiales

Allomyces anomalus Emerson, Lloydia, *4*: 133. 1941. A single isolate representing the genus *Allomyces* was obtained from soil collected in a fallow field near Fond Parisien (site 22). Since the sporophyte invariably produces RS zoospores which give rise to asexual plants, it is assumed that the sexual stage is omitted from the life-cycle. According to Emerson (1941), such isolates are assigned to the binomial *A. anomalus*.

Saprolegniales

Aphanomyces laevis deBary, Jahrb. wiss. Bot., 2: 179. 1860. *A. laevis* was observed twice on snake skin bait from laterite soil collected under grass near Furcy (site 16). Oogonia were formed in abundance and these were in no way different from previously described isolates.

Brevilegnia linearis Coker and Braxton, J. Elisha Mitchell Sci. Soc., *42*: 214. 1927. This species was isolated twice from laterite soil in a pine forest near Refuge (site 9). *B. linearis* is distinguished from other members of the genus by the elongate sporangium containing spores in a single row.

Brevilegnia diclina Harvey, J. Elisha Mitchell Sci. Soc., 42: 243. 1927. A single isolate of *B. diclina* appeared in one of the collections from from Refuge (site 20). This species differs from *B. linearis* and from *B. subclavata* by the elongate nature of the sporangium, the majority of which contain spores arranged in more than one row.

Dictyuchus sp. (H8). An interesting isolate of *Dictyuchus* was observed once from tropical-brown, fallow soil collected near Poste Terre Rouge (site 8). The oogonia appear similar to those of *D. monosporus* but are irregularly roughened. They measure 28-30 μ in diameter and contain single oospores, measuring 21-23 μ in diameter. The antheridia are diclinous and occur singly (rarely 2 per oogonium). In the Haitian isolate the sporangia are mostly of the true-net type. Less frequently, but not uncommon, are the false-net type of sporangia. Sometimes the entire sporangium breaks free to float away as in some species of *Brevilegnia*. Achyloid

sporangia have not been observed. Further study may reveal this isolate to be a species distinct from those previously described.

Leptolegniella keratinophilum Huneycutt, J. Elisha Mitchell Sci., Soc., 68: 110. 1952. The highly characteristic sporangial stage of this fungus was observed in a number of collections (sites 6, 8, 14, 16) on snake skin bait. Thick-walled spores were observed, but rarely. No additional information can be added to the incompletely known life-cycle of this fungus.

Peronosporales

Pythium debaryanum Hesse, Inaugr. Dissert. Halle. 1874. The most frequently encountered member of the genus appearing in nine soil samples (collections made at sites 2, 4, 8, 9, 11, 14, 16, 18 and 22) was *P. debaryanum*. From those species producing non-proliferating spheroidal sporangia and smooth-walled, aplerotic oogonia, *P. debaryanum* may be distinguished by the presence of several antheridia, these being both monoclinous and diclinous. When monoclinous the antheridia originate some distance from the oogonium, never adjacent to it.

Pythium ultimum Trow. Ann. Bot., *15*: 269-312. 1901. A single isolate of *P. ultimum* was recovered from a soil sample collected under a cactus at Cul-de-Sac (site 10). It may be distinguished from *P. debaryanum* only in the consistent formation of monoclinous antheridia originating closely adjacent to the oogonia. Differences in the thickness of the oospore wall were not apparent in the Haitian material. Furthermore, sporangial germination by zoospore formation was frequently observed in this material. Subsequent sub-cultures, however, produced sporangia germinating only by germ tube. The writer concurs with Van Luijk (1934) in the contention that the differences between *P. ultimum* and *P. debaryanum* are insufficient to warrant the retention of the former binomial as a distinct species.

Pythium vexans deBary, Jour. Bot., *14*: 105-126. 1876. Two isolates of *P. vexans* were obtained from soils collected at Cul-de-Sac (sites 1 and 6). This species may be distinguished from other members possessing non-proliferating, spheroidal sporangia and smooth-walled, aplerotic oogonia by the characteristic antheridia. These are monoclinous in origin, arising in close proximity to the oogonium. The shape of the antheridial cell was variable, not necessarily bell-shaped as stated by Middleton (1943).

Pythium undulatum Petersen, Bot. Tidssk., 29: 345-440, 1909; and *Pythium intermedium* deBary, Bot. Zeit., 39: 553-558. 1881. A total of five isolates of the spheroidal sporangial type were obtained which failed to form sexual stages under the cultural conditions (sites 3, 4, 10, 17 and 21). Since these isolates were examined periodically for a period of six months and since all methods for the induction of sex organs were unsuccessful, it is assumed that these isolates lack the ability to reproduce

sexually. Two of these isolates produced papillate, proliferating sporangia with sessile vesicles characteristic of *P. undulatum*. Another asexual isolate formed non-proliferating sporangia in a catenulate manner characteristic of *P. intermedium*. The additional asexual isolates lacked a distinguishing characteristic and were not identifiable.

Pythium mamillatum Meurs, Wortelrot, Verrorzaakt door Schimmels vit de Geslachten *Pythium* Pringsheim en *Aphanomyces* deBarry. 1928. A single isolate of *P. mamillatum* was obtained from alluvial soil collected under cacti at Fond Parisien (site 17). It is readily distinguished from other echinulate oogonial species by the plerotic oogonium and the relatively short conical, obtuse nature of the oogonial protuberances.

Pythium afertile Kanouse and Humphrey, Papers Mich. Acad., 8: 129-140. 1927. Three isolates of *Pythium* species bearing the filamentous type of sporangium and lacking the sexual stage were observed (sites 5, 12 and 20). As is customary, all such isolates may be cited under the binomial, *P. afertile*. The writer concurs with Middleton (1943) in recognizing the possible difficulties arising from the practice of assigning a binomial to an organism of this type. The binomial may be maintained as reference to a distinct species lacking a sexual stage or it may be regarded as including a variety of related species, the sexual stage being absent at the time of observation. Once the sexual stage is encountered, transference to another binomial would be mandatory.

Pythium catenulatum Matthews, Studies on the Genus *Pythium*. 1931. A single isolate of this species was obtained from tropical brown soil collected in a fallow field near Poste Terre Rouge (site 18). Typical irregularly inflated sporangial elements were observed in abundance. Oogonia were rarely formed. When observed, these were smooth-walled, plerotic, with several to many monoclinous and diclinous antheridia. As far as the writer can determine, this is the first report of *P. catenulatum* isolated from soil.

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EXPERIMENTAL INFECTIONS OF CHICK EMBRYOS WITH TETRAHYMENA PYRIFORMIS

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Thompson (1958), in experiments dealing with facultative parasitism in the protozoan genus *Tetrahymena*, was able to establish infections in 7-day-old chick embryos with strain WH-6 of *Tetrahymena pyriformis* (referred to as strain WH-1 in 1958 paper). This strain was able to infect the fluid contents of the egg and also penetrated into the circulatory system and general musculature of the living embryo.

The present investigation was undertaken to determine the susceptibility of various stages of chick embryonic development to infections with strain WH-6 of *T. pyriformis*.

Axenic cultures of strain WH-6 of *T. pyriformis* were inoculated into chick embryos at various stages of incubation (days 3, 5, 7, 9, 11, 13, 15, and 17). Twelve eggs of each stage were inoculated with a tuberculin syringe using a size 27 needle. Eggs were examined at daily intervals for six days after inoculations to determine infections.

Embryos in eggs inoculated at days 3 and 5 of incubation were alive after 24 hours but all were heavily infected and dead after 48 hours. Embryos of eggs inoculated at the 7th day of incubation were alive after 24 hours, but all except 4 were heavily infected and dead after 48 hours; these 4 were dead after 72 hours. All embryos of eggs inoculated at the 9th day of incubation became infected and were alive after 48 hours; five embryos were alive at 72 hours, two were alive at 96 hours but were dead at 120 hours. Eggs were candled through the 9th day of incubation to determine the condition (alive or dead) of the embryos. Embryos of eggs inoculated at the 11th day of incubation were alive when examined up to six days after inoculation. Ten of 12 eggs were infected. Embryos of eggs inoculated at the 13th day of incubation were alive when examined up to six days after inoculation. Eight embryos were not infected. One embryo examined late on the 19th day of incubation was found to harbor thousands of Protozoa in the yolk sac which at this time was found in the body cavaity of the embryo but still remained a separate sac attached to the gut. All embryos except two in eggs inoculated at the 15th day of incubation were alive when examined. Four were not infected. One chick was examined 48 hours after hatching and thousands of Protozoa were found in the yolk sac which was still a separate part of the gut. All embryos except two inoculated at the 17th day of incubation were alive when examined. Two eggs did not hatch and

were not infected. Six embryos examined were alive but not infected. Four chicks were examined after hatching and one was found to contain a few Protozoa in the yolk sac.

The results of this experiment show that infections with strain WM-6 of *Tetrahymena pyriformis* occurred in all stages of inoculated chick embryos. Fatal infections were established in all eggs inoculated through the 9th day of incubation. It was observed that in these fatal infections the older the embryo at time of inoculation the longer it survived. Older embryos (11th through 17th day) seemed to survive infections quite well. Here it was also noted that the general tendency to resist infections increased with age of embryo.

Death of the embryos, particularly those at older stages (9th-17th day), was not caused by protozoan invasions of the embryo proper since sections of musculature of the body wall, liver, intestine, and caecum revealed no ciliates. Phase microscopical examination of the fluid contents of the eggs revealed no bacteria.

Strain WH-6 of *Tetrayhmena pyriformis* was inoculated into developing chick embryos at various stages of embryonic development (days 3, 5, 7, 9, 11, 13, 15, and 17) to determine the most susceptible stages for infection. Younger embryos were more susceptible, but infections were established in all stages inoculated. One embryo carried the infection through embryonic development and the yolk sac contained Protozoa as long as 48 hours after hatching.

This investigation was supported by grants from the Virginia Academy of Science and the American Academy of Arts and Sciences.

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A STUDY OF THE CHLOROPHYTA OF THE JAMES RIVER BASIN, VIRGINIA
II. ECOLOGY[1]

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The number of species of Chlorophyta (82) along with three species of Rhodophyta and four species of Chrysophyta (*Vaucheria*) seem quite poor for the area covered in this study. There are many factors, however, that might contribute to such a low number of species. It has been suggested that many forms may be missed in collections due to the fact that they may reach their climax and disappear before they can be collected; especially so if one is only making seasonal surveys as was done in this study. Another factor that may influence the number of species is rate of current. Many forms are unable to inhabit the swifter streams, becoming more or less planktonic as they mature; thus they are carried away by the currents if there are no other plants or debris with which they may become entangled. Many streams, because of the swiftness of the currents, therefore, are unfavorable for most planktonic forms as well as for many attached forms. The pH of the water may also determine what species will inhabit a particular stream. It has been suggested that pollution also may have an influence on the distribution of species.

The above mentioned factors are only a few of the possible numerous ones which may influence the number of different kinds of species that may inhabit a particular stream or streams of a particular locality. Table 1 lists 20 streams that are considered as possibly the main drainage points of the James River Basin. In this table the pH, hardness ($CaCo_3$ content), nitrogen (NO_3 content), pollution, and swiftness of the stream are considered. The number of genera found in each stream is divided into those that are considered planktonic and those that are normally attached or filamentous. On the basis of these data, a discussion follows on the possible influence of such factors on the number of species observed in this study.

HARDNESS AND pH OF THE WATER

It has been indicated that the acidity or alkalinity of a stream will influence the development of certain forms of algae; however, it has been observed that many forms will grow within a wide pH range. It is

[1] This paper is Part II of a study. Part I was published in Va. Jour. Sci. Vol. 10, (n.s.): 70-82, April, 1959.

well to mention here that most streams will not reach a high acid condition similar to bogs or even other forms of lakes unless they are being polluted by mines or industrial wastes (Welch, 1952; Lackey, 1939; Conrad, 1942). Even in these instances, dilution plays an important part in that the greater the distance from the source of the pollution the less the concentration of the contaminating substance. It has been suggested by many phycologists that neutral or slightly alkaline conditions which appear to be characteristic of most temperate zone streams appear to be necessary for the growth of most of the algal species inhabiting flowing water (Blum, 1956; Welch, 1952). Examining the data in Table 1, it is observed that no direct correlation can be made as to the importance of pH on the number of species. Craig Creek has an average pH of 7.5 and eleven species. Catawba Creek on the other hand has a pH of 7.5, but only one species. Jackson River has a pH of 7.6, and its species number only two. Even though we do not see a positive correlation here, it has been observed by some phycologists (Foged, 1948; Hustedt, 1939; and Prescott, 1951) that alkaline waters have more species of plants than acid; at least this was found to be true for lakes and possibly could be true also for streams. However, pH becomes a controlling factor when water reaches very acid or very alkaline range. In this survey, the range was from 6.4-7.6. Ordinarily we expect the maximum growth rate within this range, other factors being favorable.

Hardness was analyzed on the basis of the total amount of calcium carbonate ($CaCo_3$) in water. There is a correlation between pH and hardness of water in that streams that are considered hard are usually alkaline, and those that are considered soft are usually acid; however, the amount of $CaCo_3$ may vary depending upon the degree of breakdown of this substance by organisms inhabiting the stream. Streams with less than 61 p.p.m. of $CaCo_3$ are considered soft and streams above 61 p.p.m. are considered hard. It has been suggested that slightly hard waters (alkaline) are more productive as to number of species than soft (acid) (Foged, 1948; Hustedt, 1939; Prescott, 1951). In this study it was found that streams a little on the acid side were more productive than those somewhat on the alkaline side. Maury River had a pH of 7.4 and hardness of 104 p.p.m., but only two species were found. The two species observed, however, were growing quite profusely, but at different times of the year; *Rhizoclonium hieroglyphicum* was collected in March and *Hydrodictyum reticulatum* was collected in August. Catawba Creek had a pH of 7.5 and a hardness of 154 p.p.pm.; however, there was only one species observed. Jackson River had a pH of 7.6 and a hardness of 83 p.p.m., but only two species were observed. There seems to be a little inconsistency in the data on Craig Creek in that the pH (7.5) indicates a slightly alkaline condition but the hardness is quite low (43 p.p.m.). The forms of plants observed (*Chara, Elodea, Potamogeton,* etc) are considered calciphilic forms. However, the fact

that much of the lime is taken out of the stream in metabolism and by becoming encrusted on the stalks of *Chara* and the other plants that were growing rather profusely, may explain the generally low concentration of $CaCo_3$ in the stream.

The streams that were slightly acid and/or soft were: Swift Creek which had a pH of 6.6 and a hardness of 12 p.p.m., with 12 species observed; Falling Creek had a pH of 6.5 and a hardness of 47 p.p.m., with four species observed; Chickahominy River had a pH of 6.4 and hardness of 49 p.p.m., with eight species observed; Fine Creek had a pH of 6.8 and a hardness of 15 p.p.m., with 11 species observed; however, Hardware River had a pH of 6.8 and a hardness of 15 p.p.m., but only one species was observed. The Appomattox River had a pH of 7.0 (neutral) and a hardness of 27 p.p.m., but 15 species were observed. Rivanna River was also neutral and had a hardness of 17 p.p.m., but only three species were observed. Even though the streams that were slightly acid seem to be more productive as to species number, there does not seem to be consistency in production as exemplified by the total number of soft-water streams. In other words, the factor of hardness is an important one in algal distribution, but apparently it is not the controlling factor. Possibly one can state that it is the interaction of other factors along with pH and/or hardness.

NITROGEN CONTENT OF THE STREAM

It has been suggested that nitrates are more abundant during the winter and spring months when streams are high and plant growth greatly reduced (Blum, 1953; Butcher, 1924; Kofoid, 1903; Pearsall, 1923; Wade, 1949). Such changes may be explained by the greater consumption of nitrates when plants are growing quite profusely (Prescott, 1951; Sawyer, 1944; Wade, 1949); thus tending to lower the total concentration of nitrates in the water chemistry. In this study the most productive streams had very low concentration of nitrates. To cite a few, Chickahominy River had 0.09 p.p.m., nitrates, but had 8 species observed; Swift Creek had 0.15 p.p.m. of nitrates, and 12 species observed; Fine Creek had 0.2 p.p.m. nitrates, and 11 species observed. However, there were some streams in this survey that had equally low nitrate content, but quite poor species distribution. Again to cite a few – Slate River had 0.23 p.p.m., but only one species; Hardware River with only 0.35 p.p.m., and one species observed; Rockfish River with 0.35 p.p.m., and only two species observed. It can be stated here, however, that none of the streams with more than 0.5 p.p.m. were very productive. Maury River had a nitrate content of 1.6 p.p.m., but only two species observed; Catawba Creek had 1.4 p.p.m. of nitrates and only one species, and Rivanna River had 0.7 p.p.m., nitrates, but only three species observed. Thus, it can be generalized from these results

that low nitrogen content may not enhance algal distribution, but increased algal growth may bring about a decrease in nitrogen content of a stream by utilization of the nitrate in metabolism (Prescott, 1951; Sawyer, 1944; Wade, 1949). Although pollution is to be considered later, it can be stated here that organic pollution may tend to increase the nitrogen content of a stream (Blum, 1956; Butcher, 1949; Brinkley, 1942; Lackey, 1942); therefore, Maury River with high nitrogen content seemed to be quite polluted also. Catawba Creek with the other high reading of 1.4 p.p.m. also seemed polluted and was quite turbid or muddy and had only one species observed.

STREAM POLLUTION

It has been stated by several aquatic biologists that many algal species can be utilized as indicators of pollution (Budde, 1928; Fjerdingstad, 1950; Huet, 1949; Liebmann, 1942); however, no attempt has been made in this study to indicate which species of Chlorophyta is an indicator of pollution. In polluted streams the total number of species may be reduced, however, those that will grow are more than likely to be quite prolific (Brinkley, 1942; Butcher, 1940; Lackey, 1942). Many species of *Oscillatoria*, a blue green alga, may form dense mats in polluted streams. This was observed by the author in some of the streams that seemed polluted in this survey, such as the Maury River. This is a rather large slow-flowing stream, and very little algal growth was observed outside of the two species cited; but quite good growths of *Potamogeton crispus* and *Elodea canadensis* were observed. The Appomattox River is another rather large stream that seemed polluted from sewage; however, quite a few species were observed to be growing in or around the stream in the backwashes or quiet pools formed from overflow of the stream. Some of the streams in this survey that seemed polluted were almost devoid of algal forms and higher plants as well. Rockfish River is an example of such a stream; there were only two species of algae observed and no higher aquatic plants. Another example of such a stream is the Hardware River with only one species of algae and limited aquatic higher plants. The Jackson River is another polluted stream (although the pollution is due to waste from a papermill rather than sewage pollution) with very low algal population and limited aquatic higher plants Thus, it can be concluded that pollution does tend to influence the number and kind of algal forms that will inhabit a particular stream.

RATE OF FLOW

It has been stated above that flowing water presents a hazard for the development of plants in general (Butcher, 1947; Cedergren, 1938).

Table 1. Summary of results in twenty streams

Streams	pH		$CaCo_3$[1]		NO_3[1]		Pollution		Rate of flow		Number of species	
	Below 7.2	Above 7.2	Low	High	Low	High	Yes	No	Slow	Fast	P[2]	A[2]
Craig Creek		7.5	43		0.2			−		X	7	4
Beaverdam Creek		7.1	19		0.24			−	X		3	0
Swift Creek	6.6		12		0.15		+			X	10	2
Appomattox River	7.0		27		0.35		+		X		5	10
Rivanna River	7.0		17		0.7			−		X	0	3
Maury River		7.4		104		1.6	+		X		0	3
Catawba Creek		7.5		154		1.4	+		X		0	1
Falling Creek	6.5		47		0.13		+			X	1	3
Pedlar River	6.9		13		0.2			−		X	0	2
Deep Creek	6.8		26		0.16			−	X		5	0
Rockfish River	6.8		12		0.35		+			X	2	0
Buffalo Creek		7.2	24		0.25		+			X	1	1
Hardware River	6.8		15		0.35		+			X	0	1
Chickahominy River	6.4		49		0.09			−			4	4
Cowpasture River		7.4		61	0.26			−		X	0	2
Slate River		7.2	19		0.23		+			X	0	1
Willis River	6.9		26		0.2		+		X		5	0
Jackson River		7.6		83	0.3		+			X	0	2
Fine Creek	6.8		15		0.2			−	X		7	4

1. $CaCo_3$ and No_3 determinations were made by the Department of Conservation, Division of Water Resources of Virginia

2. P — Planktonic; A — Attached

The swifter streams are usually devoid of higher aquatic plants, and only a few filamentous algal species are able to survive the rapids. *Cladophora* has been cited as one genus that does very well in the swifter streams (Blum, 1953). In general, however, the slower streams are more productive as to number of species that can become established. The possible reasons for such variation in the two types of streams – slow vs. fast – have been given by several phycologists in discussion of stream ecology (Butcher, 1946, Blum, 1956; Neel, 1951; Guimaraes, 1930); however, one can readily see the hazard involved in such a habitat. Many plankton forms, because of their habit of growth, are unable to populate swifter streams (Abdin, 1948; Allen, 1920; Cilleuls, 1926; Fritsch, 1905). Since these streams are usually poor for higher aquatics and in many instances quite poor for filamentous forms of algae, the plankton are carried down stream much more rapidly than they can reproduce or repopulate any particular portion of the stream (Allen, 1920; Kofoid, 1903, 1908; P-van Oye, 1926; Galtsoff, 1924). In the slower streams, all things being equal, these plankton forms are trapped between the higher aquatic plants and also between the filaments of the attached algal forms; thus they are able to increase their number.

In this survey it was observed that the swifter streams were a little less productive as far as numbers of species than the slower. There are a few exceptions that should be cited here. Maury River was quite slow, yet it had only two species observed; however, the stream was quite hard, muddy, and polluted which may account for the small number of forms. Craig Creek was fairly swift, however, 11 species were observed. It also can be noted here that the planktonic forms of this stream out-number the filamentous, but mention has been made above of the fact that this stream was very well populated by *Chara, Elodea, Potamogeton,* etc., which served as traps for these plankters; these aquatics were growing in the quieter portions of the stream. The Appomattox River, also a slow stream, had twice as many filamentous algae as plankters. On the other hand, Fine Creek, also a slow stream, had more plankters than filamentous species. Chickahominy River, which is also a slow stream, had as many plankters as filamentous forms. Even though no great difference can be observed here in the productiveness of a stream as to plankton or filamentous forms being affected by current rate, it can be observed that those streams that were poor for aquatics were also quite poor for plankters. Slate River had no aquatics and no plankters; however, it did have a very good growth of *Spirogyra*. The Hardware River was another poor stream for aquatics, and no plankters were observed either; however, there was a very fair growth of *Rhizoclonium*. The Jackson River was very poor for aquatics also, but had a rich growth of *Spirogyra;* however, no plankters were observed. Of course it should be mentioned here that most of the plankters considered in this survey are desmids, and these forms

are considered calciphobic (acid-loving); however, there are exceptions to every rule, for a few desmide, i.e. *Closterium moniliferum* and *C. tumidum*, will thrive just as well in a slightly alkaline habitat as in an acid one.

Summary

In summarizing the results of this survey, several observations can be made.

1. The number of species of Cholorophyta inhabiting the tributaries of the James River Basin is quite low.

2. The pH of these streams range from 6.4-7.6. Within this range, it is quite difficult to determine the influence of pH on the number of species; however, the streams that had the largest number of species were slightly on the acid side of the pH scale. It has been suggested that the pH exerts its greatest influence when quite low on the acid side or quite high on the alkaline side of the scale.

3. Streams that were slightly soft or low in $CaCo_3$ content had the greatest number of species; however, on the basis of hardness alone it is quite difficult to determine the direct influence of this one factor on the distribution of species in this study. Rather, it is thought that other factors interacting with hardness tend to influence the distribution.

4. The nitrogen content of a stream does influence the distribution of species; however, the low content of nitrogen in a stream may be influenced by the volume of growth in a stream. When growth rate is low, then nitrogen-content may be high.

5. Pollution may be a factor limiting the number and kinds of species that will inhabit a particular stream. Organic pollution may tend to increase the nitrogen-content of a stream; therefore, acting as a fertilizing factor. The streams in this study that seemed polluted were quite poor for numbers of species; however, those forms that were able to survive were quite prolific in their growth.

6. The swifter streams in this survey had fewer species than the slower. There were a few exceptions in that two or more of the slower streams were not especially productive, but this was thought to be due to other factors as pollution, hardness, pH, turbidity, etc. In general the swifter streams were almost devoid of both algae and higher aquatic plants, but those that could survive the hazard of swift currents usually thrived very well.

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NEWS AND NOTES

(Editor's Note: — News contributions should be sent to the person whose name appears at the end of the appropriate sections.)

MESSAGE FROM THE PRESIDENT

The thirty-eighth annual meeting of the Virginia Academy of Science will be held in Richmond on May 11-14, 1960 with the Jefferson Hotel as headquarters. It is appropriate that the University Center in Virginia, whose cooperation with the Academy made possible the securing of a grant from the National Science Foundation to support our Visiting Scientists Program, should serve as sponsor for the meeting.

The Council and all section chairmen join me in urging Virginia Scientists to report on their research and to encourage their students to "try their wings" with papers. Attention is called to the fact that a member submitting a paper can also enter it in competition for the J. Shelton Horsley award. In addition to your Section Meeting, plan to attend and participate in the business meeting and the Academy Conference. The guest speaker for the Friday night meeting will be Dr. Harry F. Harlow, Professor of Psychology at the University of Wisconsin. A past president of the American Psychological Association and Editor of the Journal of Comparative and Physiological Psychology, Professor Harlow has the rare ability to present sound scientific findings in a fascinating manner.

Your Academy is dedicated to the development of the scientific potential of the youth of the state. May I urge all Senior Scientists to cooperate in every possible way with the Junior Academy and to visit its exhibits. You will be well rewarded in addition to giving encouragement to the scientists of tomorrow.

The local Committee on Arrangements under the Chairmanship of Mr. William D. Greshman, Jr., Assistant Administrator of the University Center in Virginia, with the cooperation of scientists in the Richmond area, will provide all the facilities necessary for a successful meeting. Your attendance and participation will assure its success.

William M. Hinton, *President*

MINUTES OF THE COUNCIL MEETING

NEWCOMB HALL, UNIVERSITY OF VIRGINIA, October 24, 1959

President Hinton presided with the following Council members, Committee Chairmen, and Section Representatives present:

Council: Wilson B. Bell, Robert T. Brumfield, John C. Forbes, William G. Guy, Horton H. Hobbs, George W. Jeffers, Harry G. M. Jopson, Charles F. Lane, Paul M. Patterson, Robert C. Yates; William T. Gresham, from University Center, Richmond (Local Arrangements); W. W. Scott, (Junior Academy of Science), Jackson J. Taylor (Research); James T. Calven (Geology), J. F. Hahn(Psychology), Jesse C. Thompson (Biology).

The minutes of the meetings of Council and Academy May 7-9 were read and approved.

Note was taken of the placement of the subcommittee on Education on the Long-Range Committee (See minutes of May 9, 1959) and Jesse Thompson led a discussion probing methods as to how the Academy may aid in improvement of secondary school science instruction.

Jackson Taylor gave a financial report of the Research Committee. He reported requests were slow to come in and questioned adequate publicity concerning these funds. It was recommended that Section Chairmen publicize this. The Editor of the Journal had, in past years, notified Section Chairmen of deadlines concerning abstracts and the Research Committee Chairman notified them of the Horsley Award. It was recommended that the President write the Section Chairmen a letter concerning all deadlines.

W. W. Scott reported that the Junior Academy members were active over the summer and the Committee had had their fall meeting. For the Visiting Scientists Program, John C. Forbes reported that of those invited, 14 had accepted to visit Virginia colleges. They have been divided between 26 colleges with two institutions, as a rule, sharing one person for a week. He pointed out that applications to the National Science Foundation would have to be made at an early date if we wished to try this program a second year. After some discussion Roscoe Jackson moved that such an application be made for next year to N.S.F. The motion was seconded and passed.

President Hinton read the pro tem. financial report Foley Smith had mailed to him. He then called attention to the fact that the Teacher-Sponsor Scholarships at the University of Virginia and the College of William and Mary were not filled by appointees nor alternates. It was suggested that several alternates be named.

Dr. Hobbs reported the Committee to nominate an Editor and Business Manager for the Virginia Journal of Science (see minutes of Council meeting of May 9, 1959). The slate consisted of Robert Ross as Editor and Robert Kral as Business Manager. He moved their appointment and the motion passed.

Dr. Brumfield said review articles for the Journal were hard to get and pointed out several aspects of their importance. He further called attention to the rising costs of printing, thus making the Journal unable to pay its own way. Furthermore, surplus funds were rapidly being used up. Discussion arose as to the ways of increasing the Journal's income. President Hinton reported that he would appoint a committee to study this.

Dr. Scott sought permission for obtaining a speaker for the Junior Academy whose evening program would be over by 8:00 p.m. Thursday so as not to conflict with the senior annual Academy Conference on May 12, 1960. Dr. Hobbs moved that permission be granted and the motion was passed. Dr. Scott suggested some move be made to improve the visitation of senior scientists to the Junior Exhibits.

Dr. Forbes moved that if the Finance Committee finds it feasible, the Secretary, as well as the Treasurer, be given expenses to attend AAAS meetings when they are held east of the Mississippi River. The motion passed.

President Hinton announced that the next meeting would be held in the spring in Richmond.

The meeting adjourned.

Paul M. Patterson, *Secretary*

RETIREMENTS

LINWOOD H. WARWICK. Geological Survey Assistant with the Division of Mineral Resources, Department of Conservation and Economic Development, Charlottesville, Virginia, retired after fifty years and nine months of service. It is thought that Warwick may hold the record for continuous employment at one office among geologists in this country. He began his career with the Division of Mineral Resources on October 8, 1908 as a stenographer when he was an undergraduate at the University of Virginia. He remained there until his retirement on June 30, 1959. When he began his work, he and Dr. Thomas L. Watson, State Geologist, comprised the entire staff at the Division of Mineral Resources. There are now twenty-two persons employed there headed by Dr. James L. Calver.

Linwood Warwick was born June 14, 1887. He is the son of the late John H. and Martha Rebecca Mann Warwick, lifelong residents of Charlottesville. He graduated from the old Midway High School and later was awarded the degree of bachelor of science from the University of Virginia. On October 3, 1936 he married the former Miss Mary Elizabeth Hatcher of Lynchburg. They have no children. They live at 113 Observatory Road, in Charlottesville.

Warwick is a charter member of the Thomas Jefferson Chapter, Sons of the American Revolution, serving some time as secretary-treasurer to the chapter. He is a life member of the Jamestown Society. His church affiliation is with the Christ Episcopal Church, where he once sang in the choir.

His hobbies include genealogy, music and theatricals. It is his boast that he is the only male alumnus of St. Anne's School for girls, where he studied voice. As a High School student he wrote poetry, some of which was published in the Charlottesville *Daily Progress*. At seventy-two he remains a keen student and a man of varied interests.

ARTHUR BALLARD MASSEY, Professor of Biology at Virginia Polytechnic Institute retired June 30, 1959. He was born January 10, 1889. He is the son of the late W. F. Massey and Aurilla J. Phoebus Massey. In 1913 he married the former Modd M. Miller (deceased) by whom he had a son, James W. Massey. In 1951 he married the former Violet B. Lockwood.

Mr. Massey received the Bachelor of Science degree from North Carolina State College in 1909, and the Master of Science degree from Virginia Polytechnic Institute in 1928. In 1956 he was awarded the degree of Doctor of Science from Lynchburg College, Lynchburg, Virginia. He taught at Clemson University from 1910 to 1913 and at Alabama Polytechnic Institute from 1913 to 1918, where he held the rank of Assistant Professor. He joined the faculty at Virginia Polytechnic Institute in 1918 and rose to the rank of Professor.

In 1915 he was nominated Fellow of the American Association of Sciences, and in 1958 he was the recipient of the Wine Award at Virginia Polytechnic Institute. He is a member of Sigma Xi, Phi Sigma, the Botanical Society of America, the Southern Appalachian Botanical Club and the Virginia Academy of Science. Since 1935 he served as Chairman of the Academy's Flora Committee. He has published several bulletins through the Virginia Agricultural Experiment Station.

Throughout his long and distinguished career as a "pansy picker" he has brought together a herbarium at Virginia Polytechnic Institute of from 25,000 to 30,000 sheets. The bulk of this collection was gathered by

Dr. Massey and represents the largest herbarium of the flora of Virginia in the Commonwealth. The herbarium also contains materials from the Gulf and Atlantic coasts north to New York State. Of special interest are some of Ravenal's sheets collected in South Carolina in 1875.

Since retirement Mr. Massey may be found actively at work in the herbarium. Every so often he may be found afield in knee boots, jophurs, jacket, hat, pipe and with loaded vascula beside him. He does not seem to take retirement too seriously.

AGRICULTURAL SCIENCE SECTION

Miss Beth Jordan, Professor of Home Economics Education in the Department of Vocational Education at Virginia Polytechnic Institute, has been granted a 6 month leave of absence to do advanced work at Ohio State University. Miss Jordan succeeded Professor Martha Creighton who retired on October 1, 1959.

Dr. T. J. Horne presented a progress report of the National Young Farmer Study at the annual convention of the American Vocational Association in Chicago. Dr. Horne, Head of Agricultural Education in the Virginia Polytechnic Institute Department of Vocational Education, is chairman of the association's national committee on research in agriculture.

Dr. R. W. Engel, Head of the Department of Biochemistry and Nutrition at Virginia Polytechnic Institute recently returned from a tour of duty as a consultant for the Department of Health Education Service. Duties took him to the Philippines, Japan, Formosa, Vietnam, Rome and Geneva.

Dr. M. S. Read has accepted a temporary appointment to replace Dr. K. W. King who is serving in Haiti for Columbia University while on leave-of-absence from Virginia Polytechnic Institute. Dr. Read comes to Virginia Polytechnic Institute from the Army Medical Nutrition Research Laboratory, Denver, Colorado, where he was in charge of contract programs at academic institutions and in private research laboratories for the Office of the Surgeon in connection with wholesomeness testing of foods sterilized by ionizing radiation. During his appointment, Dr. Read will offer a special course in the technology, biochemistry, bacteriology and nutritional aspects of food irradiation.

Dr. G. C. Graf has been elected president of the Virginia Polytechnic Institute Chapter of the AAUP. Dr. Graf is Head of the Department of Dairy Science.

Professor P. M. Reaves, Professor of Dairy Science, Virginia Polytechnic Institute, recently attended the meeting of the American Feed Manu-

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facturers Association. He is a member of this group's Feed Survey Committee which reviews the feed supply and demand in the United States.

The following members of the staff of the Department of Dairy Science at Virginia Polytechnic Institute will present papers at the Association of Southern Agricultural Workers meeting in February: Dr. W. K. Stone, Dr. V. L. Baldwin, Dr. M. F. Ellmore and Professor W. S. Griffith. Dr. G. C. Graf, Head of the Department is a member of the auditing committee of the ASAW and a director of the Southern Division of the American Dairy Science Association

Mr. W. L. Beane has been appointed Assistant Professor of Poultry Husbandry at Virginia Polytechnic Institute. Mr. Beane, who received his M.S. from the University of Maine, will work primarily in the field of poultry management.

Dr. A. T. Leighton, Jr., has been appointed Associate Professor of Poultry Husbandry at Virginia Polytechnic Institute. He received his M.S. from the University of Massachusetts and his Ph.D. from the University of Minnesota. Dr. Leighton will conduct research in turkey genetics and physiology.

Mr. A. N. Huff, returns to Virginia Polytechnic Institute in January as Livestock Extension Specialist. He has been on leave while serving in the Army. Mr. C. R. Cooper, former Livestock Extension Specialist, has been changed to Instructor in Animal Husbandry teaching and research.

Dr. R. F. Kelly, Mr. P. Graham and Dr. J. P. Fontenot of Virginia Polytechnic Institute's Animal Husbandry Department recently presented papers at the annual meeting of the American Society of Animal Production in Chicago.

Paul B. Siegel, *Virginia Polytechnic Institute*

BIOLOGY SECTION

Mr. Robert Kral was appointed Associate Professor of Biology at Virginia Polytechnic Institute to fill the vacancy created by Mr. A. B. Massey's retirement June 30, 1959. Mr. Kral received the B.F. degree from North Carolina State University in 1952 and the Ph.D. degree from Florida State University in 1952. Mr. Kral is now serving as Manager for the Virginia Journal of Science.

Mr. Henry S. Mosby, Mr. Byrd S. McGinnis and Mr. Robert D. Ross and graduate students of Virginia Polytechnic Institute attended the joint meetings of the Southeastern Section of the Wildlife Society and the Southeastern Association of Game and Fish Commissioners at Baltimore,

Maryland, September 21-25, 1959.

Mr. Henry S. Mosby of Virginia Polytechnic Institute is editing a "Manual of Game Investigations Techniques." The manual is now approximately 75% in proof. When ready for distribution it will fill an urgent need for a comprehensive treatise on wildlife techniques.

Mr. William W. Scott of the Department of Biology, Virginia Polytechnic Institute, attended the Summer Institute for College Botany Teachers at Indiana University, Bloomington, Indiana, from June 20 to August 20, 1959. The Institute was sponsored by the National Science Foundation. On January 15, 1960, Mr. Scott plans to go to the University of Wisconsin, Madison, Wisconsin, where he will serve as Visiting Professor of Botany. He expects to return to Virginia Polytechnic Institute June 10, 1960.

The Flue Cured Tobacco Variety Evaluation Committee met at Blacksburg November 30-December 1, 1959. Mr. H. E. Hegestad, of the United States Department of Agriculture, Beltsville, Maryland was appointed Chairman and Mr. M. J. Rogers, Superintendant of the Chatham Bright Tobacco Research Station was elected Secretary of the Committee for 1960.

Mr. Samuel A. Wingard, General Chairman, and Mr. George M. Shear, Secretary of the Horticulture Section, attended the Cumberland Shenandoah Fruit Worker's Conference at Hagerstown, Maryland November 19-20, 1959. Mr. Shear recently prepared Leaflet 448 "Growing Watercress" for the United States Department of Agriculture.

Mr. James M. Grayson and Mr. Donald G. Cochran of the Department of Entomology at Virginia Polytechnic Institute, attended the joint meetings of the Entomological Society of Ontario, the Entomological Society of Canada and the Entomological Society of America at Detroit, Michigan, November 30 to December 3, 1959. Mr. Grayson gave two papers: "Laboratory selection of the German cockroach for resistance to Malathion and Diazinon," and "Resistance to DDT and Chlordane in the German cockroach following discontinuance and restoration of selection." Mr. Cochran gave a paper: "Nucleotide dephosphorylation of sarcosomes from the American cockroach."

Mr. Dietrick H. F. A. Bodenstein has been appointed Chairman of The Department of Biology at the University of Virginia, and is expected to assume his new duties about February 1, 1960. Mr. Bodenstein, an insect physiologist, comes from the Gerontology Department of the Baltimore City Hospital. He was elected to the National Academy of Sciences in 1958. Mr. Horton H. Hobbs, Jr., has recently been serving as Acting Chairman of the department.

Mr. Smritimoy Bose, for several years a Research Fellow of The Blandy Experimental Farm – after receiving his Ph.D. at the University of Virginia in 1959, has accepted a temporary appointment as Assistant Professor of Horticulture, Purdue University.

The following have been among recent out-of-state scientific visitors at The Blandy Experimental Farm – Amar Nath Khanna (Government Agricultural College, Kanpur, India); Remedios J. Fernandez (of the Philippines); Seleh Idris (Bogur Botanical Garden, Java, Indonesia); A. E. Brandt (University of Florida); B. Obesfanks (University of Pisa, Italy); T. S. Osborne (University of Tennessee-A.E.C. Laboratory); Sydney Cross Harland (University of Manchester, England); Charles W. Rick, (University of California, Davis).

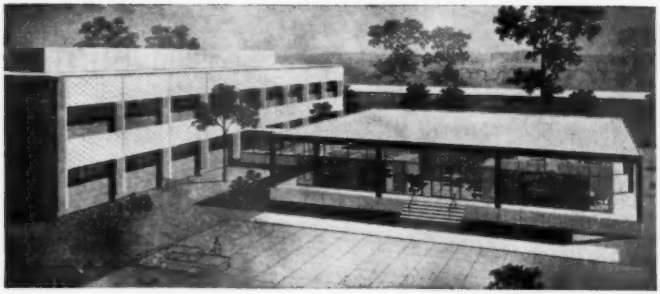
Walter S. Flory, Jr., *University of Virginia*

ENGINEERING SECTION

Professor Fred W. Bull of the Chemical Engineering Department at Virginia Polytechnic Institute presided at the regional meeting of the Industrial and Engineering Chemistry Division of the American Chemical Society held November 6 in Richmond. N. F. Murphy, F. W. Bull, P. W. Ruggieri, Jr., and R. C. Hart presented a paper on "Decolorization of Caustic Wash Liquors from Chlorine-Bleached, Sulfate, Wood Pulp." Professor N. F. Murphy and Dr. Arthur Doumas have been awarded U. S. Patent No. 2,902,416 on a "Method and Bath for Electrodeposition of Aluminum." In November Dr. Murphy spoke to the Hartford, Connecticut Branch of the American Electroplaters' Society on the subject of "Metal Electrodeposition from Non-Aqueous Systems."

Dean Lawrence R. Quarles of the School of Engineering at the University of Virginia attended a meeting as a member of the Board of Directors of the American Nuclear Society in Gatlinburg, Tennessee in June. He is chairman of the Educational Sub-Committee of this Society. He also attended the annual meeting of the American Society for Engineering Education in Pittsburg as a member of the Executive Committee of the Engineering Colleges Administrative Council. In November Dr. Quarles attended a meeting of this Council in St. Louis, Missouri. Dean Quarles has been appointed by Governor Almond to the State Nuclear Advisory Committee and in November, as a representative of the State, he attended a meeting of the Regional Advisory Council on Nuclear Energy in Nashville, Tennessee. Dean Quarles was invited to present a lecture on "Nuclear Energy in the South" at Southwestern at Memphis in November.

Mr. Tilton E. Shelburne, Director of the Virginia Council for Highway Investigation and Research, at the University of Virginia, and Professor R.



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E. Lee Gildea of the Civil Engineering Department attended the annual meeting of the American Society of Civil Engineers in Washington in October. Mr. Shelburne is a Director for Division Six of this Society. In November Mr. Shelburne attended the Bureau of Public Roads Construction and Maintenance Conference and spoke to this group on the work on Skid Prevention done by the Council.

Professor J. Lawrence Meem of the Nuclear Engineering Department at the University of Virginia attended the National Meeting of the American Nuclear Society in Washington in November. He is a member of the Student Branches and Local Chapters Committee. At that time he also met with the sub-committee on Research Reactors of the National Research Council.

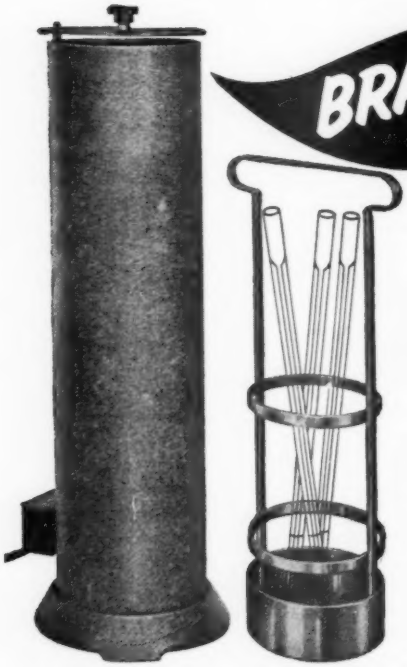
In June Professor Robert M. Hubbard of the Chemical Engineering Department of the University of Virginia attended a summer school for chemical engineering teachers on process dynamics held at Case Institute of Technology and sponsored by the National Science Foundation and the Foundation for Instrumentation Education and Research. Professor Hubbard has been elected Chairman of the Central Virginia Section of the American Institute of Chemical Engineers for the year 1960. Professor Otis L. Updike of the Chemical Engineering Department at the University was employed at the Oak Ridge National Laboratory during the summer. He is on leave of absence from the University during the academic year 1959-1960 and is working at the California Institute of Technology on a National Science Foundation Fellowship. In December he attended the annual meeting of the American Institute of Chemical Engineers in San Francisco.

Mr. Bernard Niemier is now Head of the Mechanical and Strain Measurements Group in the Metallurgical Research Laboratory of Reynolds Metal Company.

Robert M. Hubbard, *University of Virginia*

PSYCHOLOGY SECTION

Frank A. Geldard attended the organization meeting of the NATO Advisory Group on Defense Psychology, held at NATO Headquarters in Paris on November 2-3. Dr. Geldard is chairman of the Advisory Group which includes representatives from Italy, the Netherlands, France, the United Kingdom, and the United States. The chief business of the meeting was the laying of plans for an international symposium on defense psychology, to be held in Paris just prior to the 16th International Congress of Psychology at Bonn in July 1960. Areas to be encompassed by the symposium program are: Identification and assessment of human abilities,



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Frank W. Finger is president-elect of the Division of General Psychology of the American Psychological Association. At the 1959 meetings of the A.P.A. in Cincinnati, Richard H. Henneman read a paper(prepared jointly with Kenneth E. Lloyd) on "The Influence of Number of Different Stimulus Categories on Short-term Retention." William F. Battig chaired a session on Human Learning sponsored by the Division of Experimental Psychology.

At the Chicago meeting of the A.A.A.S. in December, the Vice-presidential address for Section I will be given by Frank A. Geldard from the University of Virginia. Dr. Geldard will speak on "Some Neglected Possibilities of Communication."

Four psychologists were approved for certification by the Virginia Examining Board for Certification of Clinical Psychologists after examination on November 4. They were George Killinger, Marion; Meredith Green, Winchester; Henry Adams, Richmond; and Luther Mays, Arlington. This brings to 63 the number of Certified Clinical Psychologists approved by the Virginia Examining Board.

At the fall meeting of the Virginia Psychological Association in Winchester, October 30, Capt. James F. Wade, Wright Air Force Base, presented a paper on weightlessness entitled "Human Factors in Stress and Space Flight." Joel Greenspoon, Director of the Clinical Psychology Training Program, Florida State University, gave the banquet address, "Clinical Aspects of Verbal Conditioning." The business meeting was delightfully informal; the treasurer had lost his report, but he assured the members that the funds were in a safe place. The president kept misplacing his brief case, and somehow the meeting found itself adjourned in the middle of a discussion. The Zeingarnik effect immediately clamped down on the group so that the discussion continued into the following social hour and occasional reverberations are still heard.

Henry Adams, McGuire VA Hospital, presented a paper at one of the meetings sponsored by Division 12, in Cincinnati, entitled "Preliminary Investigation of Behavioral Concomitants of Sensory Deprivation." This paper was also selected for inclusion on the program of the VA Symposium on Medical Research. Robert Gibby read the paper on this occasion, which was in Cleveland, Dec. 8-11.

John F. Hahn is the newly elected president of the University of Virginia chapter of the Society of the Sigma Xi; William F. Battig now serves as the chapter treasurer.

Charles C. Hodge, M.A., from the University of Mississippi has joined the William and Mary Psychology Department as Instructor for the year

1959-1960. Also, for the same year, David S. Camp, as Assistant Instructor.

George Gerken joined the Psychology Department at the University of Virginia in September. He comes from the University of Chicago where he carried on his doctoral research in auditory electrophysiology. Dr. Gerken also holds a degree in electrical engineering from Massachusetts Institute of Technology.

Kenneth E. Lloyd left the University of Virginia in August to join the Psychology Department at Washington State University, Pullman, Washington.

John McMillan, formerly of McGuire VA Hospital and more recently with Rohrer, Hibler, and Replogle, Atlanta, became Chief Psychologist, Department of Neurology and Psychiartry in the Medical College of Virginia, January 1, 1960.

Cyril R. Mill, *Department of Mental Hygiene and Hospitals*

STATISTICS SECTION

Dr. Boyd Harshbarger and Dr. H. A. David of the Department of Statistics of the Virginia Polytechnic Institute attended and presented papers at the Fifth Conference on the Design of Experiments sponsored by the Office of Ordnance Research, U.S. Army, held at Fort Detrick, Frederick, Maryland, November 4-6, 1959.

W. A. Glenn completed the requirements of a Ph.D. degree in Statistics and has accepted a position as Associate Professor in the Department of Statistics of the Virginia Polytechnic Institute.

Miss Carmen A. Perez and Mr. Giulio Damiani completed the requirements for their Masters degrees in Statistics at the Virginia Polytechnic Institute. Mr. Damiani is planning to return to his home in Italy.

The following members of the Department of Statistics of the Virginia Polytechnic Institute will attend and present papers at the joint Christmas meetings of the Institute of Mathematical Statistics, the American Statistical Association, and the Biometrics Society, ENAR ,in Washington, D. C.: Drs. Boyd Harshbarger, W. A. Glenn, H. A. David, R. J. Freund, Rolf E. Bargmann, Clyde Y. Kramer; and Mr. David C. Hurst.

The Virginia Academy of Science Chapter of the American Statistical Association held a joint meeting with the Richmond Section of the American Society for Quality Control in October 24, 1959, at the Holiday Inn Restaurant, Lynchburg, Virginia. Four papers of an expository nature were presented. The meeting was attended by approximately twenty persons.

The following papers have been published by members of the Department of Statistics of the Virginia Polytechnic Institute:

"Analysis of Variance of a Randomized Block Design With Missing Observations," W. A. Glenn and C. Y. Kramer, *Applied Stat.* Nov. 1958.

"Errors Associated with Process Adjustments," J. Edward Jackson, Richard A. Freund, and William G. Howe, *Virginia Journal of Science*, 10 (1), 1959.

"Some Multivariate Statistical Techniques Used in Color Matching Data," J. Edward Jackson, *Journal of the Optical Society of America*, Vol. 49, No. 6, June, 1959.

"Tournaments and Paired Comparisons," H. A. David, *Biometrika*, Vol. 46 Parts 1 and 2, June, 1959.

"The Comparison of the Sensitivities of Similar Experiments: Model II of the Analysis of Variance," D. E. W. Schumann and Ralph A. Bradley, *Biometrics*, Vol. 15, No. 3, September, 1959.

Norbert L. Enrick was promoted to Associate Director of Research and Head of Operations Research Division, Institute of Textile Technology, in Charlottesville.

TIME STUDY MANUAL is the title of a book, written with particular reference to problems of continuous processing and complex machine-operator cycles, to be published in January 1960 by Interscience. It was prepared by twenty-seven contributors, mostly members of the Southern Textile Methods and Standards Association, and edited by N. L. Enrick.

Dr. Franklin E. Satterthwaite, professor at Merrimack College, head of the Statistical Engineering Institute, and consultant with Rath and Strong Inc., presented an all-day seminar on Statistical Methods in Polyvariable Experimentation for students and staff members at the Institute of Textile Technology. Special attention was given to Random Balance designs, of which Dr. Satterthwaite is the originator.

Clyde Y. Kramer, *Virginia Polytechnic Institute*

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NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Robert T. Brumfield, Stevens Hall, Longwood College, Farmville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost. The author may estimate the length of his paper by counting the total number of characters, including blank spaces, and dividing this by 3300. The result is the approximate number of printed pages in the Journal.

Division of the manuscripts into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

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Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula Va. Journ. Sci., 1 (8): 285-288 1 fig., 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired: either "Sniffen (1940)", (Sniffen, 1940: 186)", or "Sniffen (1940) states that . . ."

Explanation of figures, graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

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